LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published Monthly by

The Texas Company, 17 Battery Place, New York City

Vol. XIII | August, 1927 | No. 8

Change of Address: In reporting change of address kindly give both old and new addresses.

Theory and Practice of Steam Cylinder Lubrication

IN the maintenance of industrial and power plant machinery, there are certain phases of lubrication which will have so decided an influence upon power economy and machine production as to warrant repeated discussion of the salient factors involved.

These latter must be appreciated and understood if effective lubrication is to be ultimately accomplished. Further study of the matter of steam cylinder lubrication will, therefore, be advisable and should prove of decided interest to all who may have to do with this varied phase of power plant lubrication.

The use of steam as a medium of power generation will in general involve a number of requirements from the viewpoint of lubrication, which are normally foreign to the operation of any equipment except the reciprocating steam engine, steam pump or compressor. Pressure, temperature and moisture must all be considered, for each will have a decided influence upon the degree to which effective lubrication will ultimately be attained.

Furthermore, whether or not exhaust steam is to be used for process heating purposes, returned to a feed water heater or "just wasted" must also be taken into account, for use of an excess of cylinder lubricant and its presence in exhaust steam may cause trouble in those systems where perishable goods such as textiles may be involved. If returned to the boilers, on the other hand, certain lubricating constituents may give rise to deposits on tube surfaces, blistering and subsequent failure.

In effect steam cylinder lubrication will require more detailed consideration of actual operating conditions than any other phase of general plant lubrication. Yet, the potential problems which may result will not usually be difficult of solution, provided that the conditions to which the oil may be subject are properly analyzed.

CONSIDERATION OF OPERATING CONDITIONS

The several operating conditions that a cylinder oil will have to meet in performing its functions are:

1. Steam pressure,
2. Temperature,
3. Velocity,
4. Moisture in the steam,
5. Degree of superheat,
6. Priming or foaming,
7. Point of introduction,
8. Boiler compounds, and
9. The use (if any) which is to be made of the exhaust steam.

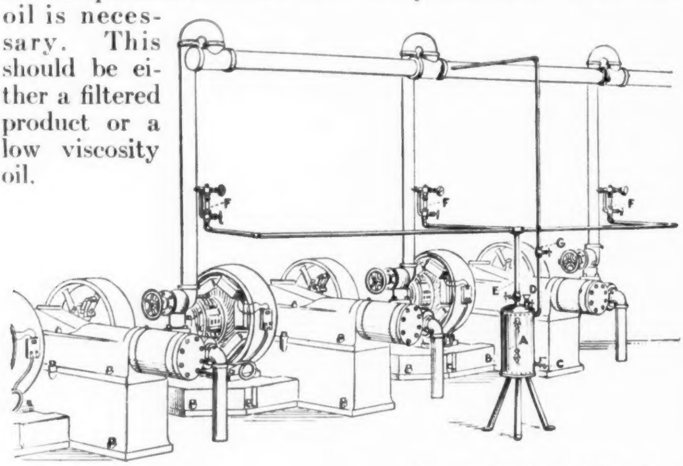
Relation of Pressure to Temperature, etc.

While steam pressure alone will have but little influence upon a cylinder oil, the temperature associated with the pressure, as well as the degree of superheat to which the steam may be subject, has a very marked effect.

The usual operating temperatures in the steam cylinder and valve chest must be taken into consideration when selecting any cylinder oil due to the effect which they may have upon the viscosity of the oil film on the cylinder walls and valve seat. In other words, viscosity will be decreased accordingly as steam temperatures are increased. Therefore, where operating with high temperature saturated or superheated

steam a heavier bodied oil should be used, or else the flow of lighter lubricant increased sufficiently to compensate for its lesser viscosity.

Conversely where steam pressures are low, or where a partial vacuum with accompanying low temperatures exist, a more easily atomized oil is necessary. This should be either a filtered product or a low viscosity oil.



Courtesy of The Lunkenheimer Co.

Fig. 1—A central tank multiple feed, hydrostatic lubricating system. "A" is the oil storage reservoir; "F" the respective lubricators.

High Flash Point Not Essential

The effect of higher temperatures upon the actual chemical behavior of the oil in the engine will normally be negligible. For example, the "operating temperature" for saturated steam at even 600 pounds will be but 486.6 degrees F. This is below the open flash point of any cylinder oil. Furthermore, it is probable that the flash point would be raised with the increased pressure. As a result, there does not seem to be any reason for the common belief that a very high flash or fire test is necessary. Saturated steam always contains moisture and as there is no free oxygen present in the steam it does not seem likely that a flash could be produced in the cylinder regardless of the flash point of the oil.

High Temperature and Velocity Improve Atomization

Steam temperature and velocity, however, affect the atomization of the cylinder oil to a marked extent. Thus, the higher the temperature and velocity the more readily will a heavy bodied oil be atomized, due to the reduction in viscosity which occurs at the temperature of operation.

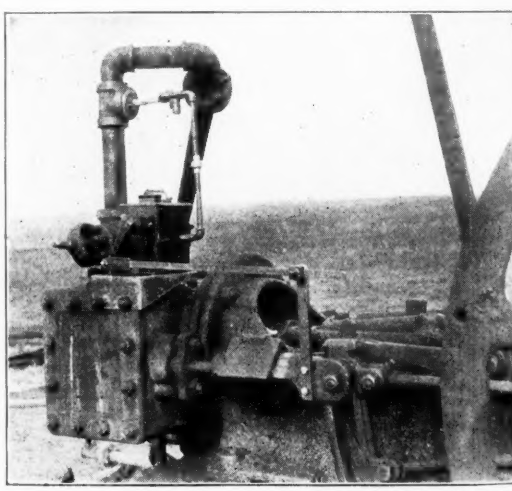
Moisture Most Important to Consider

From the viewpoint of the actual composition of a cylinder oil, the question of moisture in the steam is the most important factor involved. Steam will always contain a certain percentage of moisture unless it is superheated to a sufficient extent to counteract any line and cylinder condensation, which may be caused by the cooling effect of the piping, cylinder walls and the expenditure of heat by the expansion stroke. The presence of moisture in steam will usually result in a film of straight mineral lubricating oil being rapidly washed off from the cylinder walls and other surfaces with which the steam comes in contact. Therefore, to secure proper lubrication under wet steam conditions it is necessary to either increase the rate of flow of the straight mineral oil, or else substitute an oil which contains a certain percentage of fatty compound such as lard oil, degras or tallow.

When to Use Straight Mineral Oils

The practice of using a straight mineral oil to lubricate wet steam is customary only where the presence of a fatty oil in the exhaust steam is objectionable. The increased amount necessary to insure proper lubrication will often result in imperfect atomization. As a consequence, oil accumulations in the cylinder will be prevalent and carbon deposits developed.

Especially will the above be true in multiple expansion engines equipped with receivers and re-heaters, the high temperatures to which the oil is subject being very conducive to carbonization. In poppet valve engines carbon formation of this nature may often cause imperfect operation of the valves.



Courtesy of Madison-Kipp Corp.

Fig. 2—A mechanical force feed lubricator installed for steam cylinder lubrication on an oil field pump. Note that the entire equipment is exposed to the weather.

The Purpose of Compounding

Where a compounded oil is used an emulsion is developed by the moisture in the steam re-

acting with the fatty component. The lubricating film thus has a greater affinity for the cylinder walls and other wearing surfaces and becomes highly resistant to the washing action of the water in the steam. Naturally the greater the percentage of moisture in the steam the higher should be the fatty compound content of the lubricant. In general the compound should not exceed 10%, however, except in extreme cases of abnormally wet steam. We must remember that an excessive amount of fatty compound, beyond that necessary to form the requisite emulsion, will not improve the lubricating value of the oil. In fact, it may even be an objection, especially under continued exposure to high temperatures, on account of the tendency that animal fats have of decomposing under such conditions.

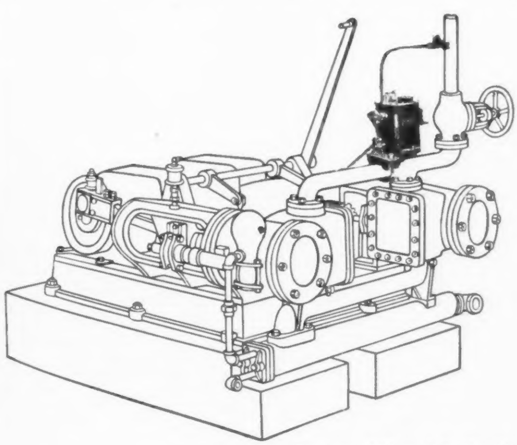
Amount of Compounding

In regard to the proper amount of compound to use in an oil, it can be said that this should be just sufficient to maintain a film of oil on the cylinder walls. This is especially true where the exhaust steam is to be used for feed water heating or in process work of any nature. Under such conditions it is more important than ever to observe caution in selecting and using steam cylinder lubricants.

Present day practice is to more and more reduce the quantity of compound and to improve its quality.

That tendency in compounded oils which causes them to unite with water to form emulsions in the cylinders also prevents ready separation from water in condensed steam; furthermore, the more completely atomized the oil, the more difficulty will it have in separating from water.

Oil in the form of fine emulsions in a boiler combines with the boiler compounds to cause foaming, or with the boiler impurities to produce a coating over the tubes and fire surfaces. This coating seems to form more readily over relatively clean tubes than over dirty ones.



Courtesy of Manzel Brothers Co.

Fig. 3—A single feed lubricator installed on a twin cylinder drilling engine. Note method of attachment to steam line.

A very thin layer of oily sludge over a tube surface will so insulate it that there is not only a large loss in heat efficiency, but the rise in temperature of the metal may be so excessive as to cause the burning out or explosion of the boiler.

REQUIREMENTS OF SPECIFIC TYPES OF ENGINES

In a determination of steam cylinder oil requirements, engine design and construction must, of course, be considered in detail.

Function of the Lubricant

The function of a steam cylinder oil is to lubricate every sliding surface which is either in direct contact with the steam, or subject to its pressure and temperature. Therefore, steam valves, valve rods, slide valve seats, cylinder walls, pistons, piston rings, piston rods and throttle valves are involved. These parts are not always subject to the same pressure and temperature conditions, yet the one oil must serve throughout, and, therefore, it must be sufficiently flexible in operation to produce efficient lubrication wherever necessary.

Influence of Valve Design

Steam valve design is a decided factor in cylinder lubrication.

There are, broadly, four types of such valves, i.e.,

1. The slide or D-valve,
2. The piston valve,
3. The Corliss, and
4. The poppet valve.

The Slide or D-valve

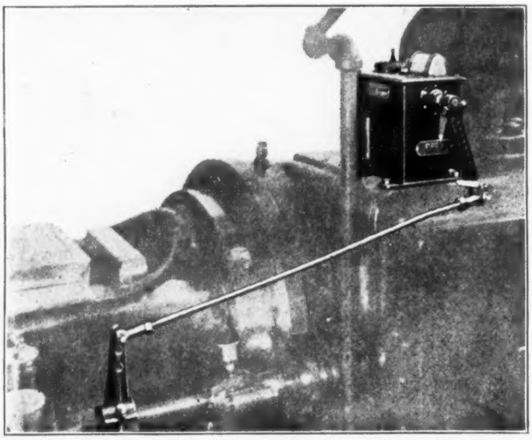
The common slide valve is one of the most difficult to lubricate due to inequalities of pressure and the consequent "wiping" action which it exerts upon the lubricated valve seat. Therefore, the oil film must be continuously renewed, otherwise ineffectual lubrication may result, with cut or worn valves and seats. The above can normally be detected by the jerky motion of the valve stem which is caused by momentary sticking of the valve to the seat.

The Piston Valve

With the piston valve, on the other hand, the steam pressure is balanced, and as a result there is less tendency for the oil to be squeezed or wiped from the valve seat. As a result, piston valve engines can operate under considerably higher pressures than certain other types of engines.

The Corliss Valve

The Corliss valve is a slide valve to the extent that it is subject to a certain amount of sliding action on its curved seat. There is not a great area of contact, however, hence, although it is subject to unbalanced steam pressures, this type of valve can carry higher pressures than a plain D-valve. One of the difficulties in lubricating a Corliss valve is to maintain a suitable film of lubricant at the end of the valve. As a result individual feeders for the lubricant are frequently installed at such points.



Courtesy of Detroit Lubricator Co.

Fig. 4—Showing in detail the necessary connections from a mechanical force-feed lubricator to the reciprocating parts of a steam engine.

Poppet Valves

Poppet valves, while reciprocating in action, are not subject to sliding on the valve seat. As a result lubrication at this point is relatively unnecessary. Valves of this type are also balanced as to steam pressure; hence they are capable of operation under higher pressures the same as piston valves. They are extensively used in certain types of uniflow engines.

Poppet valves require lubrication of the stems only. It is essential, however, to regulate the flow of lubricant carefully and to guard against an excess, otherwise abnormal carbonization of the oil will occur and the valves will stick.

Horizontal Engines Require Most Attention

In the horizontal cylinder, except where tail rods are used, the weight of the piston, rings and part of the weight of the piston rod must be borne by the lower portion of the cylinder. On account of this weight the piston will frequently tend to wear the bottom of the cylinder out of round, and unless sufficient lubrication is provided, the clearance between the piston and the cylinder may become so great as to cause serious leakage of the steam past the piston. This increases the pressure to which the oil film is subjected and may weaken or entirely destroy it.

If the rings become worn and sharp on the edges they will scrape the oil film off the surface of the cylinder walls, to further increase the friction and wear. Because of these conditions the cylinder oil must have the characteristics which will provide a heavy film of oil and must be used in sufficient quantities to maintain it. Even with the most efficient oil a certain amount of wear will take place and the rings will have to be renewed occasionally.

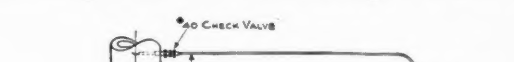
Tail Rod Supports an Advantage

Engines having heavy pistons and rods are, therefore, usually provided with tail rod supports, which, together with the cross head, carry the weight of the former. In such engines the only pressure on the cylinder walls is that carried by the tension of the piston rings, and a thinner film of oil and a lesser quantity of lubricant are required.

Vertical Engines

Vertical cylinders, on the other hand, are comparatively simple to lubricate as the weight of the piston, piston rod, cross head and connecting rod are carried by the crank pin. The only pressures on the cylinder walls are those due to the tension of the piston rings and possibly to some slight pressure from any side motion which the piston may have.

The rings, no matter of what design, should be accurately set, and just tight enough to prevent any abnormal steam leakage. A film of oil thick enough to prevent excessive friction between these rings and the cylinder walls, and enough oil to maintain this film, are all that is required to provide proper lubrication.



Courtesy of S. F. Bowser & Co., Inc.

Fig. 5—Method of mounting a mechanical lubricator for steam cylinder lubrication on a high speed engine. Note drive connection from valve rod.

The selection of oil is based on the same principles that govern the oil used for horizontal

cylinders, though the quantity required will probably be considerably less.

Vertical Marine Engine Cylinders Frequently Not Lubricated

In the vertical marine engine where the condensed steam is used as make-up boiler feed, wherever adequate oil separation may be impracticable, it will frequently be advisable to run without any cylinder lubrication, on the assumption that the amount of water present in the steam will afford the necessary lubrication.

The space rings and piston usually have water grooves to hold a small amount of condensed steam which serves to decrease steam leakage, making it possible to use looser fitting rings and consequently decreasing the friction. After a short time, these cylinder walls become highly polished and glazed, so that the actual friction is lessened.

Rod Lubrication

Valve rods, piston rods and tail-rods, to operate effectively, of course, require quite as efficient lubrication as valve seats and cylinder walls. While it is usually considered the duty of a cylinder oil to lubricate these latter, we must never forget that detrimental results may occur if they are neglected.

While in general, such rods will receive sufficient lubrication from the oil in the steam it is frequently customary to either install auxiliary sight feed oil cups or make some other provisions for oiling the rods externally at regular intervals.

We must remember that both valve and piston rods are very accurately machined and adjusted; therefore, any overheating due to lack of lubrication might cause a change in alignment, with ultimate damage to the internal mechanism of the engine.

Poppet valves, in particular, will tend to stick, etc., unless the valve stems are well lubricated and free from carbon.

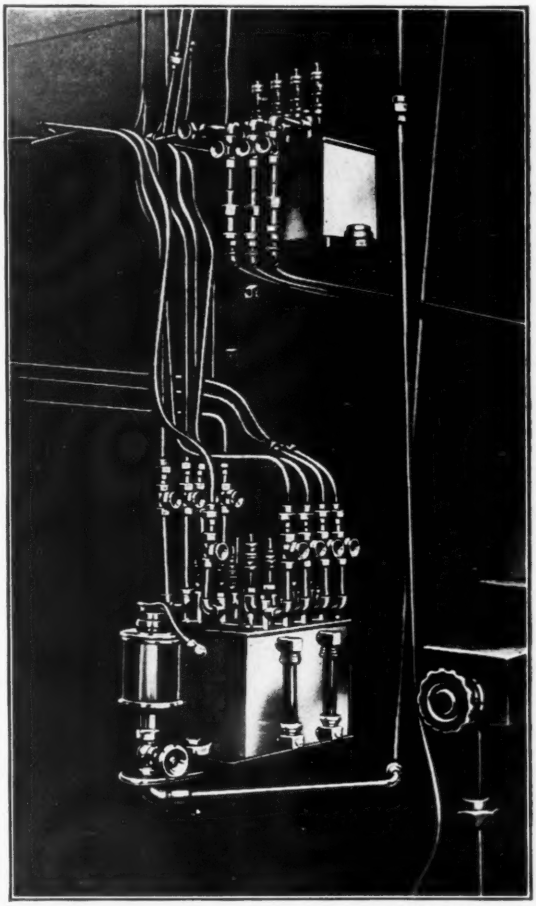
TYPES OF LUBRICANTS

To effectively meet the average requirements it has been determined that steam cylinder oils must be of comparatively heavy body and have a particularly adhesive characteristic in order to insure the maintenance of a lubricating film which will resist the wearing or scraping effects of the average valve and piston, and washing off by the steam itself.

Viscosity Essential

Viscosity or body is attainable by suitable refining; adhesiveness by judicious treatment of the so-called cylinder stock by the addition of certain fixed or fatty animal oils.

As a general rule it will be essential to use an oil having a viscosity range of between approximately 100 and 160 seconds Saybolt at 210° F., according to the steam pressure and temperature involved, the type of steam valves and the means of application available.



Courtesy of Hills McCanna Co.

Fig. 6—An installation of force feed lubricating equipment as applied to a steel mill blowing engine.

Steam the Actual Lubricator

The most efficient way of getting the lubricating oil to all desired points is to make use of the steam itself, which reaches all moving elements inside of the valve chambers and cylinders with the possible exception of parts of certain types of Corliss valves.

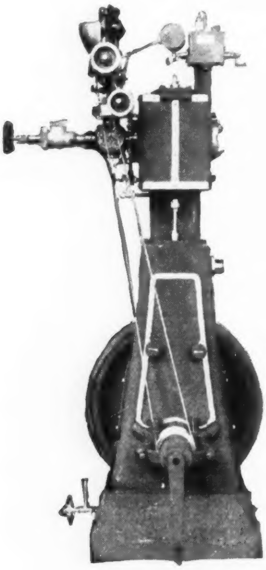
If the oil is divided into minute globules and intimately mixed with the steam, only a very small quantity is required, and the degree of success in the atomization of the oil will control both the efficiency of lubrication of the parts and the quantity necessary.

Atomization the Salient Factor

The more complete the atomization and the more thoroughly saturated all portions of the steam, the better will be the lubrication of all

of the cylinder parts, and the more economical will be the consumption of oil.

The degree of atomization of the oil is influenced by the condition of the steam, the point of introduction of the oil, the velocity of the steam, and the character of the oil itself.



Courtesy of McCord Radiator and Mfg. Co.

Fig. 7—A stoker engine equipped for mechanical force feed cylinder lubrication. A unique feature is the method of drive from the extended valve stem as shown at the top right hand side of the picture.

High Pressure Promotes Atomization

Other things being equal, a high steam pressure will produce quicker atomization of a given oil than a low steam pressure, due to the high temperature thinning down the oil to a greater extent, so that a comparatively heavy bodied oil may be atomized by a high pressure steam as quickly as a light bodied oil will be atomized by a low pressure steam.

In general, a low pressure steam requires a light bodied oil in order to secure efficient atomization.

Furthermore, a filtered oil will atomize more readily than an unfiltered product. Also, compounding with animal oils will tend to improve the atomizing ability of the average cylinder stock.

The degree of atomization is also affected by the point of introduction of the oil into the steam, in that the farther the point of introduction is from the cylinder, the greater will be the opportunity for complete atomization.

METHOD OF APPLICATION OF THE LUBRICANT

With a knowledge of the parts of a steam cylinder requiring lubrication, we are next concerned with the application of the lubricant.

This is accomplished by either one of two methods:

1. Where the oil is applied directly to each of the separate wearing surfaces, and
2. Where the oil is fed into the steam line between the throttle valve and the steam chest, the steam serving to atomize it and carry it to all moving parts within the valve chest and cylinder.

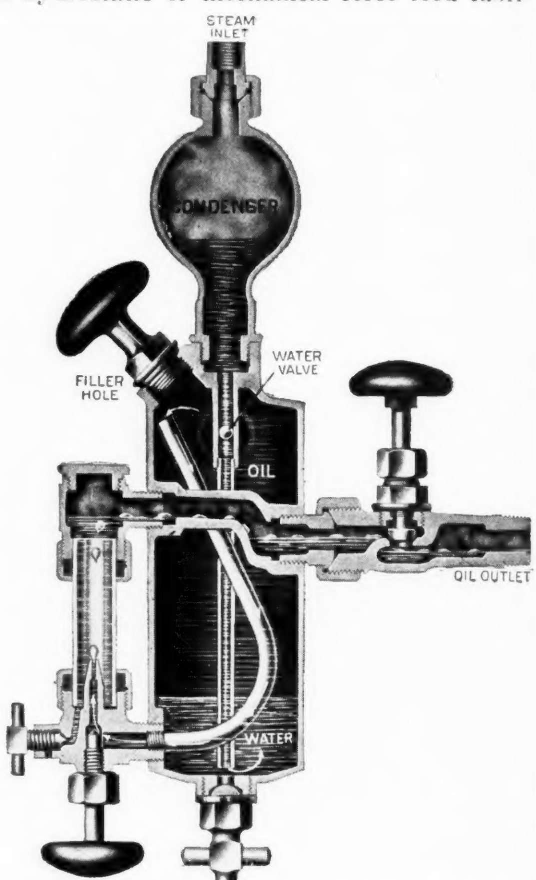
Direct Application

Direct application of steam cylinder lubricants by means of individual oilers installed on the valve chest and cylinder is the more crude and uncertain of the two methods. In this case, the lubricant is fed drop by drop into the engine, being spread over the wearing surfaces by the movement of the valve and piston. Valve, piston and tail rod glands are often similarly equipped with drop feed oilers.

It is perfectly evident that such a method of lubrication, while probably not objectionable in the case of a single cylinder engine, would be decidedly cumbersome and unreliable if applied to a multiple cylinder unit. In fact, there would be so many points requiring attention that the possibility of lack of lubrication would be very great.

Automatic Lubrication

For this reason steam cylinder lubrication by means of injecting oil into the steam line, using a hydrostatic or mechanical force feed lubri-



Courtesy of Michigan Lubricator Co.

Fig. 8—Sectional view of a hydrostatic lubricator showing constructional details.

cator, is regarded as far more dependable and conducive to increased efficiency.

The fact that the steam in its passage through the engine reaches practically all of the surfaces requiring lubrication, insures the trans-

mission of the particles of oil which it carries, to these parts. However, sufficient oil must be fed to the steam line and the point of introduction of the lubricant must be located at a suitable distance beyond the throttle valve and the steam chest to enable the steam to completely exercise its atomizing effect.

Oftentimes this is spoken of as "lubricating the steam." Complete atomization is the secret of steam cylinder lubrication. If any of the oil is carried into the cylinder in liquid state its lubricating effect is lost, as it will either be swept out prematurely by the rush of exhaust steam, or not be able to distribute itself uniformly over the wearing surfaces.

Point of Introduction Most Important

The point of introduction is, therefore, of the utmost concern. In general, if this is located at a distance of from six to eight feet above or preceding the throttle valve, unless abnormal conditions arise, atomization can be depended upon to be complete by the time the lubricated steam reaches the throttle valve, and the latter will be quite as effectively lubricated and rendered capable of as efficient operation as the working parts of the engine.

If the point of introduction is located too close to the throttle valve or cylinder, complete atomization may not take place; if too far away there will be a possibility of the oil particles being thrown to the walls of the steam line, from whence a flow of liquid lubricant will occur to the valve chest.

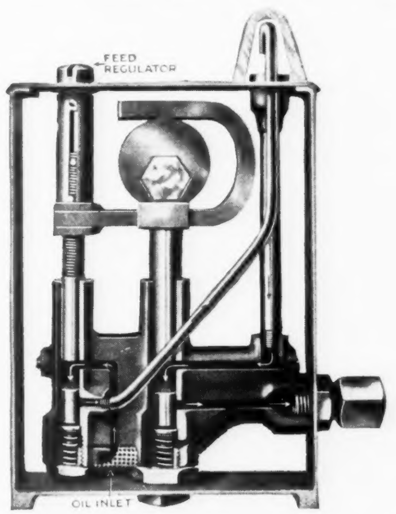
In effect this might well be termed condensation of the lubricant, and it will be quite considerable if there are any bends or other pipe fittings located between the lubricator and the valve chest.

If the oil is introduced directly into the valve chest or just above the throttle, a product must be used which will break up very quickly. On the other hand, if the point of introduction is from six to eight feet from the cylinder, as stated above, it is possible to use a slower acting oil if other conditions render it necessary or advisable.

Further, if it is found necessary to use a heavy bodied oil to meet the cylinder conditions, better lubrication may be secured at a more economical cost by placing the introduction of the oil further back from the cylinder.

In extreme cases where such conditions occur, it may often be necessary to install auxiliary direct-feed lubricators upon the valve chest or cylinder, even though a waste of oil will be probable.

In multiple expansion engines equipped with receivers between the cylinders, the flow of steam may often be so checked as to cause the oil particles to be thrown down and deposited in the receivers. Where such is found to occur it will be advisable to install lubricators on each steam chest. The oil feed in such cases, however, should be carefully regulated, inasmuch as but little make-up lubricant is usually necessary to compensate for that lost in the receivers.



Courtesy of Manzel Brothers Co.

Fig. 9—Sectional view of the pumping unit of a double plunger type force feed lubricator showing travel of oil, piston valve motion, eccentric on hexagon driving shaft, and feed regulator.

TYPES OF LUBRICATORS

Granting that automatic lubrication will usually be adaptable to the average steam engine, we are therefore concerned with two types of lubricators, i.e.,

1. The hydrostatic and
2. The mechanical force feed type.

The Hydrostatic Lubricator

The hydrostatic lubricator embodies the principle of forcing the oil drop by drop, into the system by means of a head of water which is maintained by condensing of the steam.

In other words, flow of oil is intermittent, drops being fed into the steam line at intervals, depending on the adjustment of the regulating valve and the viscosity of the oil. A heavy bodied oil will flow through the sight glass slowly in large drops, while a lighter bodied oil will feed in smaller drops at more frequent intervals, the latter condition giving the more uniform and more complete saturation of the steam.

In this regard it will sometimes be noticed that the oil will not feed properly, that it runs up the side of the glass, discoloring it and rendering it impossible to observe the feed. This is frequently caused by the use of a steam gauge glass. If it is not possible to get a proper glass, the size of the drop may be reduced by filing

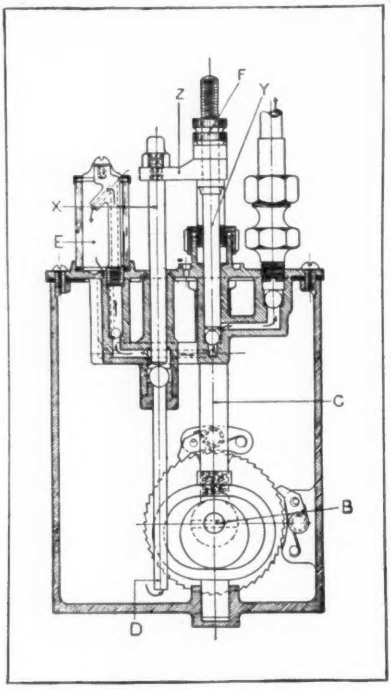
down the lip on the feed valve and soldering a fine wire to the latter to allow the oil to follow the wire. If the oil backs up in the sight feed glass, it is usually due to lack of enough difference in the pressure on the sides of the lubricator and may be improved by increasing the distance between the two connections into the steam pipe.

Not Entirely Positive

A hydrostatic installation cannot be depended upon to be absolutely positive due to the more or less erratic nature of the conditions to which it is subject. For example, a change in temperature will affect the viscosity of the oil, the size of the globules fed, and consequently the regularity of the flow. In addition, the flow of oil will be independent of the speed of the engine, hence the working parts of the latter will seldom receive exactly the correct amount of oil to meet the conditions of operation.

The Mechanical Force Feed Lubricator

The mechanical force feed lubricator more or less overcomes certain of these objections by virtue of the fact that it is connected directly



Courtesy of McCord Radiator and Mfg. Co.

Fig. 10—The mechanism of a ratchet driven mechanical lubricator. The main shaft "C" driven by eccentric "B", moves yoke "Z" and operates "X" and "Y" the primary and delivery plungers. "E" is the sight feed; "D" the oil inlet.

to some reciprocating part of the engine, pump or compressor. Consequently oil is fed into the system at a rate which varies directly with the speed.

Such a lubricator functions only when the engine is operating, hence there is little possibility of wasted oil or the flooding of the system. An efficient mechanical lubricator should feed the same amount of oil regardless of the temperature, viscosity or amount of oil in the reservoir. In general, while a device of this nature can be used with either a direct feed or an atomizing spoon, the spoon is more commonly used.

Keep Oil Warm Where Necessary

Frequently engines are exposed to fairly low temperatures. In such cases some provision should be made to keep the oil in the reservoir warmed up, otherwise it may become thick and cease to flow through the sight feeds to the plungers.

Certain types of lubricators also are unsuitable for compound condensing engines operating with a pressure below atmosphere in the low pressure cylinder, unless the check valves on the discharge side of the lubricator are spring loaded, as the low pressure may cause the oil to be drawn out of the reservoir into the cylinder in large quantities with great waste.

PRINCIPLES INVOLVED IN DELIVERY

In discussing the type of lubricants which will usually be required for steam cylinder service on engines, pumps and compressors, the matter of atomization has been referred to in considerable detail. In fact, as already stated, proper atomization is regarded by many authorities as the real secret of effective steam cylinder lubrication.

Method of Atomization

Inasmuch as the average lubricator merely serves to feed the oil into the steam line, it is necessary to install a suitable atomizer which will insure effective breaking up of the oil before it enters the steam chest and cylinders.

Atomizers are only effective, however, provided that they are properly designed and installed. Erroneous construction or careless installation may frequently defeat any possibility of satisfactory lubrication, and oil will be consumed in a relatively useless manner due to the fact that little if any of it is able to reach the valve seats or cylinder walls in suitable condition to function properly.

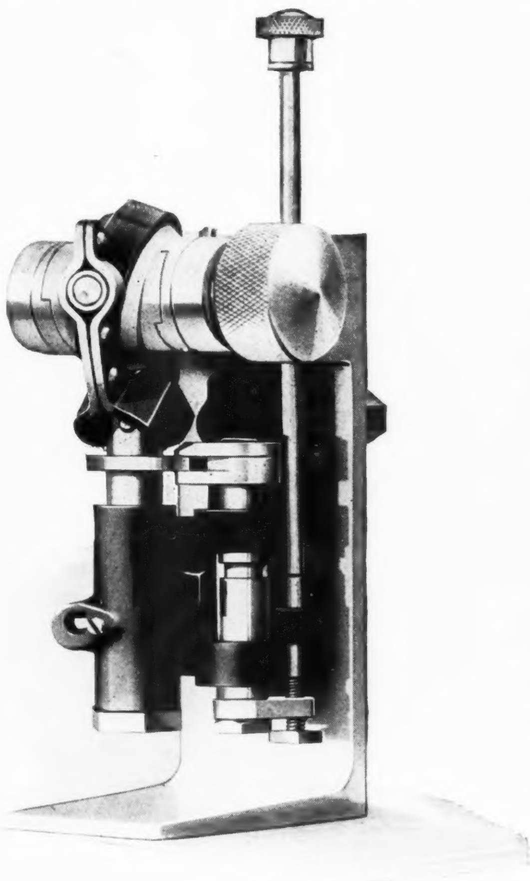
Bends Undesirable

Care should always be taken to place the atomizer so that there are as few bends between it and the cylinder as possible, as the steam, as already stated, in striking the pipe at any bend, will throw out some of the oil onto the pipe where it may stick and run down the side.

If a steam separator is installed the oil should always be fed between the separator and the engine, otherwise the separator will remove a considerable part of the oil. Better atomization

of any oil can be secured by feeding very small drops at frequent intervals than by feeding large drops at long intervals.

Practical experience and many tests have demonstrated the soundness of the atomization



Courtesy of Madison-Kipp Corporation

Fig. 11—The essential parts of a valveless type of mechanical force feed lubricator. The pumping plungers are operated or twisted up and down by means of a double motion eccentric above. Thus, as each is raised, oil is drawn in; at the top of the stroke the eccentric turns the plunger intake groove away from the inlet port in the barrel and registers the discharge groove with the discharge port. This position is held until the end of the down stroke.

theory, and the fact that most efficient results can be secured in this way.

While, of course, a considerable amount of oil which is carried by the steam never comes in contact with the metal surfaces, nevertheless, it is very evident that far less oil will be wasted when it is completely atomized than when it is introduced directly into the cylinder or valves.

The primary consideration is, of course, the efficient lubrication of the cylinders, and the oil should be selected with this in view. Then, if the point of introduction is not right to handle the oil selected, and if the mechanical conditions will permit, it should be changed to enable subsequent atomization to as complete a degree as possible.

Many times, however, it is not feasible to locate the introduction pipe at the correct point, and it becomes necessary to compromise by changing the character of the oil or by increasing the amount used.

Types of Atomizers

There are, in effect, two types of atomizers used today in power plant service. Essentially each comprises a short length of pipe or a nipple inserted in the steam pipe, its outer end being connected to the lubricator delivery pipe.

The Spoon Atomizer

Fig. 12 shows what is known as the spoon type of atomizer. This is simply a piece of pipe or nipple of the same size as the lubricator discharge, and of such a length that when inserted in the steam pipe the tip will extend somewhat beyond the center line of the latter. Both ends of the nipple should be threaded; one end with a standard length thread, the other with a long enough thread to permit it to be screwed into the steam pipe as above.

The upper part of the long thread end of this nipple should be cut away on such an angle that the remaining section will have sufficient curvature to allow for the cutting of one or more slots parallel to the axis and from one to two inches long. The tip of this nipple should be bent to a spoon-shape, the slots preferably terminating at a sufficient distance from the end to insure against loss of rigidity, although many engineers prefer to cut them through to the tip with a hack-saw.

Manner of Installation

When inserting into the line, the top-side center of the atomizer should be clearly and permanently marked for it is important that the slots be directly lined up with respect to the travel of the steam; otherwise subsequent atomization will be impaired and the steam may be unequally lubricated.

Guard Against Locating Upside Down

If by any chance such an atomizer is installed up-side down relatively no atomization will occur, the oil simply dripping from the nipple. It is the action of the steam, impinging on the oil as it flows out along the exposed portion of this nipple and forcing it through the slots, which brings about the necessary atomization.

The Perforated Atomizer

Another type of atomizer (Fig. 13) makes use of a number of perforations in the nipple instead of slots, for the purpose of atomization. In this case, the nipple is usually not cut away, but remains intact, being drilled uniformly along the top and bottom (with respect to the axis) over perhaps a distance of two-thirds to three-quarters of the steam pipe diameter, with

a sufficient number of equally spaced 1/8" to 1/4" holes. The top holes should preferably be somewhat enlarged.

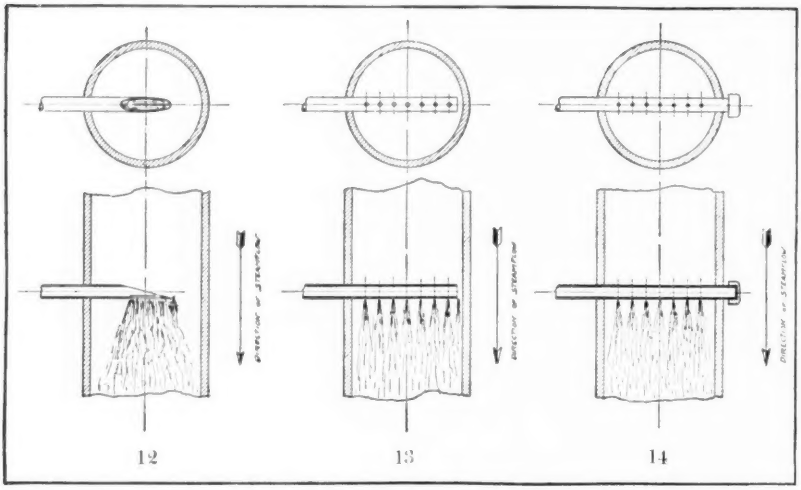


Fig. 12—The spoon-shaped atomizer. This is an exceedingly satisfactory type of atomizer serving to break up the oil effectively

Fig. 13—The perforated type of atomizer which makes use of a number of perforations in the nipple through which steam is able to pass, thereby carrying oil out with it in the form of spray.

Fig. 14—Another type of perforated atomizer which is extended through the steam pipe and capped at the outer end. Cleaning out is thereby materially facilitated. Some engineers prefer to use a valve instead of a cap at this end to permit blowing out with steam with the least amount of trouble.

The nipple may or may not be threaded over its entire length according to the way it is to be installed and attached to the lubricator fitting. Some engineers find it advisable to weld or plug up the end of this nipple which is inserted into the steam line. Others carry it through to the opposite side of the steam pipe as shown in Fig. 14.

This type of atomizer should be quite as carefully installed as the spoon-shaped device, and every care should be taken to see that the holes are directly in line with the direction of flow of the steam in order that the latter may blow through and carry the oil out in a spray.

If by chance, such an atomizer is so installed that the perforations point towards the walls of the steam pipe, the steam may not pass through, atomization will not be effected and the atomizer will simply become a dripping device.

Atomizers of this type are not always effective even when properly installed due to the possibility of the holes becoming plugged up.

Another type of perforated atomizer has holes drilled in the top of the nipple only, the steam making a turn and carrying the oil out through the end as in Fig. 15. In its installation the same care should be exercised as above.

Modified Types

Essentially, these are the only practical types of steam cylinder oil atomizers in use. Others (as in Figs. 16 and 17) which consist of an open ended nipple, or a nipple drawn down to an orifice, and inserted into the steam pipe so that the oil just flows out into the steam, are really dripping devices. Whether much atomization actually occurs when oil is thus allowed to drip into a volume of high velocity steam is often a question. Frequently the drops of oil will be swept to the walls of the pipe to simply run down perhaps as far as the throttle valve.

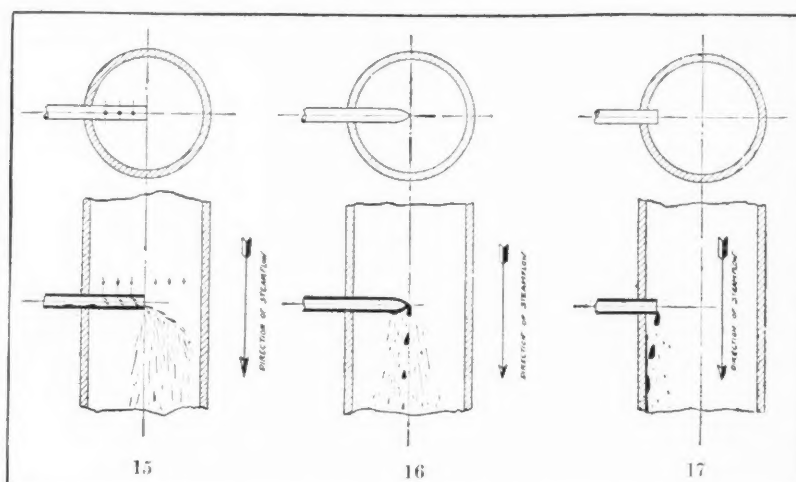


Fig. 15—The perforated atomizer can also be constructed with holes on the top side only, the steam making two right-angular turns as shown. Oil is claimed to be effectively atomized by this procedure.

Fig. 16—A drip type of atomizer in which the end within the steam line is drawn down to form an orifice.

Fig. 17—In this type of installation the extent to which atomization may occur is questionable. The further in toward the center of the steam pipe that the nipple extends, the more chance will there be for the oil drops to be broken up by the action of the steam.

SUPERHEAT CONDITIONS

Where superheated steam may be involved, the problem of cylinder lubrication is believed

by many to be a more complicated proposition than where saturated or wet steam is prevalent. This, for the reason that not only are initial temperatures higher, but also moisture conditions may frequently prevail. In fact, only in the event of comparatively high superheat will there be any superheat in the steam at the end of the expansion stroke or throughout the entire exhaust stroke.

Superheat Seldom Prevails Throughout the Engine

It is generally believed that in stationary practice unless there is approximately 200 degrees initial superheat at the throttle practically no superheat will be left in the steam at exhaust when operating at about one-quarter stroke. This means, in effect, that virtually all engines using superheat are operating on saturated steam during a portion of the expansion stroke, and throughout the entire exhaust stroke.

Consequently, instead of a purely superheated steam condition, we will have a dual problem to study in the selection of the most suitable steam cylinder oil, viz., initial superheat with subsequent saturation or moisture conditions. But the one oil must be capable of meeting both.

Carbonization a Frequent Cause of Trouble

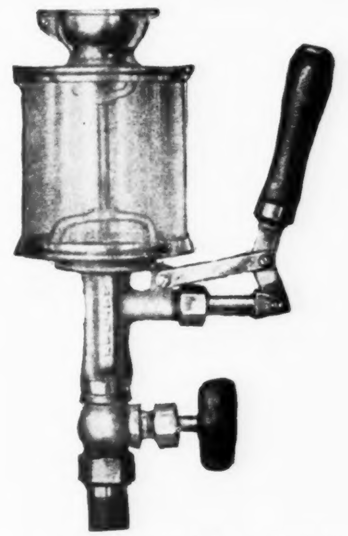
Most of the trouble encountered in the lubrication of superheated steam cylinders will be caused by carbonization of the oil and deposits on the valves at the end of the valve travel and at the end of the counterbore in the cylinders. These carbon deposits are the result of the delivery of an excessive quantity of oil to the cylinders and can be eliminated if the quantity of oil fed is reduced.

How it Is Caused

Carbonization is caused by the oil remaining in contact with the hot surfaces and the superheated steam long enough for its lighter constituents to be evaporated and the oil partially decomposed. If the oil were of such characteristics that it evaporated more readily and if it were fed to the cylinders in such small quantities that an accumulation of the oil would not be made on the valves and other parts of the engine, carbon deposits could be entirely eliminated.

The excessive oil feeds which many engineers have considered necessary for superheated steam cylinders are due to the practice of using a straight mineral cylinder oil of high viscosity and high flash and fire.

Such an oil, lacking compound, while suitable for the lubrication of the cylinder, as long as the steam remains dry or superheated, is not suitable for the lubrication of the cylinder during that portion of the stroke when the steam is saturated, due to the fact that the subsequent moisture washes the oil off the cylinder walls, the latter becoming dry. This will result in wear and increased friction.



Courtesy of Nathan Manufacturing Co.

Fig. 18—A hand cylinder oil pump often used as an auxiliary to the sight feed or mechanical lubricator on large engines.

Consequently, the engineer will be prone to increase the amount fed, so that something like satisfactory lubrication is secured, and in doing so, such a large amount of oil may be fed to the cylinders that it will not all be carried away, to result in subsequent accumulation of carbon deposits.

Proper Oil to Use

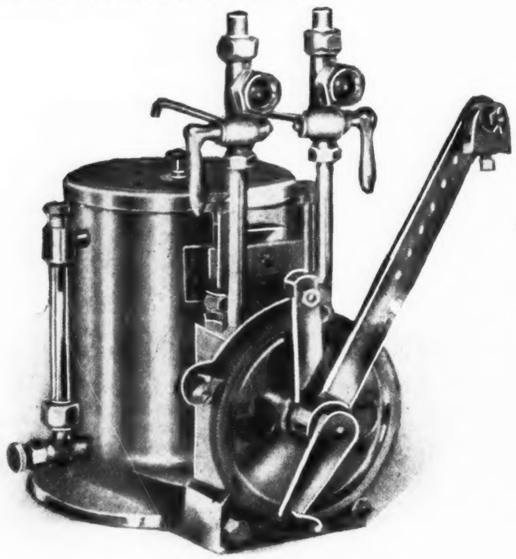
The proper oil for a superheated steam cylinder is a medium-heavy viscosity cylinder oil, having a fair amount of compounding, say perhaps 4 or 6% of animal oil. The resultant oil, on account of this compounding, will emulsify when necessary and thereby lubricate the cylinders very efficiently during that period when they are filled with saturated steam.

As the percent of compound is low no ill effects will result from the exposure of the oil to superheat conditions.

It is fully appreciated that this is somewhat contrary to the usual understanding and the general recommendations as to the properties necessary for an oil to withstand superheated steam, but the success which has attended the use of this type of oil, makes the above explanation seem to be most reasonable and logical.

THE DETERMINATION OF EFFECTIVE LUBRICATION

Having broadly reviewed the principal elements which normally enter into the selection of proper oils for use in steam cylinder lubrication under various operating conditions, etc., the matter of how to determine whether lubrication is effective is of interest.



Courtesy of Greene, Tweed & Co.
Fig. 19—A double feed automatic lubricator of the ratchet drive type, equipped with sight feed devices.

Condition of Wearing Surfaces

In general, the real test of a cylinder oil should be the condition of the wearing surfaces upon which it is used. Therefore, hasty decision as to the suitability of such an oil should be guarded against, as time is necessary for the lubricating film to form and function properly. Any test should, therefore, cover a period of several weeks. Then the engine should be shut down and the cylinder head and valve chest cover removed and the interior examined.

If upon immediate inspection the wearing surfaces show a film of lubricant sufficient to penetrate and leave a brownish stain on three or four thicknesses of cigarette paper the former may safely be regarded as being sufficiently lubricated. If below this film they appear highly polished and of a color varying from bright iron-white to steel-blue, they have been properly lubricated.

Indications of Faulty Lubrication

Where the surfaces are rough, dry, dull in appearance or rusty, lubrication has either been insufficient or the wrong grade of oil has been used. In addition, if the stain on the cigarette papers appears streaked, blackish or mottled, either the oil has been subject to carbonization or abnormal wear has taken place.

Lack of lubrication will also sometimes be shown when the engine is running, by sticky valves or groaning sounds from the cylinder. With Corliss valve systems, the slowness in action of the dash pots will also give an indication as to faulty lubrication.

Check by Observing Exhaust Steam

Economy of lubrication can be checked up by examining the exhaust steam or piston rod leakage. If the condensed steam shows considerable quantities of liquid oil, either too much oil is being fed or it is not properly atomized. If it shows minute drops of oil and is milky in color it is probable that atomization is complete and the feed is correct.

If the piston rod shows a film of oil on it and there is no oil fed directly thereto it can be taken as an indication that the atomization is satisfactory, or at least that the surfaces are receiving sufficient oil.

Excessive lubrication, on the other hand, will be indicated by pools of oil lying in the bottom of the cylinder or in the counterbore.

CONCLUSION

To sum up, under operation the efficiency of lubrication can be roughly judged by:

1. The film of oil on the piston rod
2. The amount of oil in the condensate, and
3. The action of the valves.

A suitable film on the piston rod (unless the oil is fed directly to it), minute drops of oil and a milky appearance in the condensate, free action, and little or no noise in valve operation, are indications that the oil is suitable, atomization complete, and the rate of feeding correct.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.
72 Washington St., N. Y. C.